Young Career Focus: Dr. Florian Beuerle (Julius Maximilian University Würzburg, Germany)

Background and Purpose. SYNFORM regularly meets young up-and-coming researchers who are performing exceptionally well in the arena of organic chemistry and related fields of research, in order to introduce them to the readership. This Young Career Focus presents Dr. Florian Beuerle (Julius Maximilian University Würzburg, Germany).

Biographical Sketch

Dr. F. Beuerle

Florian Beuerle was born in Bayreuth (Germany) and grew up in the rural area of Upper Franconia in southern Germany. He studied chemistry at Friedrich Alexander University in Erlangen (Germany) and graduated with a diploma in 2005. After working under the guidance of Professor Dr. Andreas Hirsch on the regioselective functionalization and antioxidant properties of [60]fullerene derivatives, he obtained his PhD in 2008. Afterwards, he moved as a Feodor Lynen fellow of the Humboldt Foundation to the group of Sir Fraser Stoddart at Northwestern University in Evanston, IL (USA). During his postdoctoral stay, he worked on various projects in the area of mechanically interlocked molecules, including supramolecular catenanes and rotaxanes as well as theoretical investigations on toroidal carbon nanotubes. In 2010, he returned to Germany and started his independent academic career as a junior research group leader at Julius Maximilian University in Würzburg (Germany) supported by a Liebig fellowship of the Fonds der Chemischen Industrie. Current research interests of the Beuerle group include covalent organic cage compounds, porous materials, supramolecular and nanosystems chemistry.

INTERVIEW

SYNFORM *What is the focus of your current research activity?*

Dr. F. Beuerle Research in our group is centered around the design and synthesis of complex molecular architectures utilizing the repetitive self-assembly of small organic building blocks under reversible conditions. Following a *molecular design approach*, we aim for tailor-made control of the structure and function of these functional materials by means of suitable building block design and appropriate choice of dynamic coupling reactions. Furthermore, we aim for new design paradigms beyond traditional synthetic protocols including self-sorting of complex reaction mixtures, and precise control of molecular hierarchy and morphology, as well as stimuli-responsive systems allowing for spatiotemporal control of assembly and function. In particular, we are interested in porous materials, for example, covalent organic cage compounds and metal-organic, covalent organic or supramolecular frameworks, in order to obtain novel materials for applications in areas such as organic electronics, host-guest interactions or energy-related issues.

SYNFORM *When did you get interested in synthesis?*

Dr. F. Beuerle From the very beginning of my undergraduate studies, I was always fascinated by the two-sided nature of chemistry as *the* molecular science that fruitfully combines both theoretical knowledge on reactivity and properties of molecules and the practical aspect of actually making compounds which might never have been made before. During my further education towards supramolecular and materials chemistry, I realized more and more that good synthetic skills still remain very essential for all aspects of chemistry, since any deeper understanding of structure–function relationships depends strongly on the availability of suitable model compounds or novel derivatives exhibiting improved properties, neither of which would be accessible without profound knowledge of chemical synthesis.

SYNFORM *What do you think about the modern role and prospects of organic synthesis?*

Dr. F. Beuerle Chemists like me who, by training, have a more applied approach towards synthesis, sometimes have the naïve notion that the main problems of synthesis have already been solved decades ago and almost any imaginable molecule can be synthesized at will. However, after some failures in the lab you will learn the hard way that the devil is in the details and that there is still a great need for improvement and development of new synthetic methods. On the other hand, I believe that, in the future, synthesis has to be seen in a much broader sense than traditional step-by-step modifications on small molecules. For example, dynamic and combinatorial approaches towards synthesizing complex systems based on multi-component mixtures will surely enlarge the chemical space greatly. Alongside this, growing interest in *chemical systems out of equilibrium* will force scientists to rethink traditional concepts of product stabilities and selectivities. Nevertheless, I am still a strong advocate for keeping courses on modern synthetic chemistry as integral parts of the curricula for advanced organic chemistry students and for pursuing basic research on new synthetic methodologies to further enhance the art of organic synthesis in the future.

SYNFORM *Your research group is active in the areas of organic synthesis and supramolecular chemistry. Could you tell us more about your research and its aims?*

Dr. F. Beuerle Our current research activities are focused on the design and synthesis of novel porous materials such as covalent organic cage compounds as well as covalent organic or metal-organic frameworks. Based on a hierarchical approach, we aim to modify these molecular architectures on various hierarchy levels. Therefore, synthetic modifications on the lowest level of the small molecule precursors are at the centerpiece of our daily lab work. On this basis, we try to obtain integrative systems with a precise spatial arrangement of multiple functional units utilizing self-sorting phenomena and directional approaches. Furthermore, we would like to get better control over solid-state arrangements of such complex molecular architectures in order to correlate molecular function with bulk properties, ultimately leading to functional devices and materials. For these purposes, we implement organic scaffolds possessing unusual geometries, for example, tribenzotriquinacenes or [60]fullerene hexakis adducts, into complex hierarchical assemblies. In particular, we are interested in porous molecular architectures in order to develop new materials for areas such as gas storage and separation, energy production and storage, sensing or specific host–guest interactions.

SYNFORM *What is your most important scientific achievement to date and why?*

Dr. F. Beuerle Recently, we reported on a series of covalent organic cage compounds based on catechol-functionalized tribenzotriquinacenes and diboronic acids (*Angew. Chem. Int. Ed.* **2015**, *54*, 10356). The geometrical shape of the cages can be rationally tuned by simply changing the angular disposition of the ditopic linkers. Moreover, in the case of complex reaction mixtures containing two different boronic acids, both narcissistic self-sorting into segregated cages as well as social self-sorting with the exclusive formation of unprecedented three-component assemblies were observed. The latter case represents the first example for social self-sorting of covalent

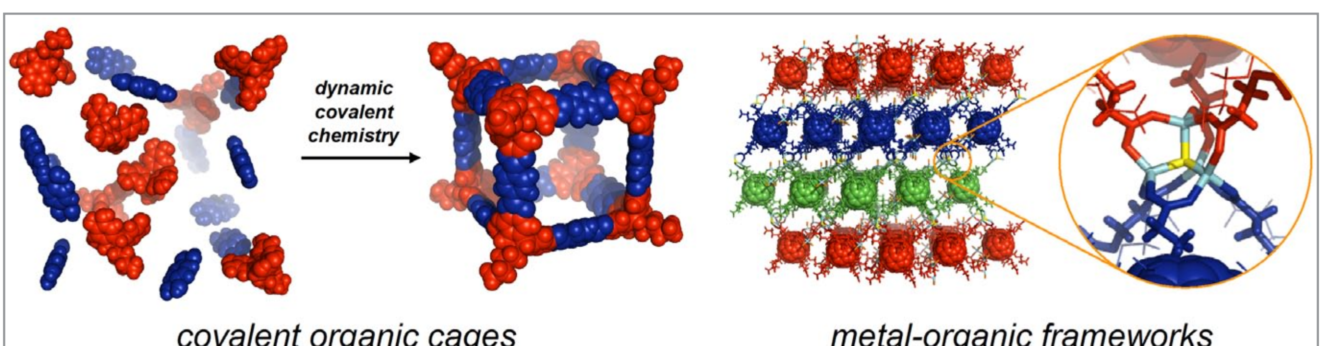

Figure 1

cage compounds and represents an important step towards the targeted synthesis of integrative systems and the next generation of cage molecules with a precise spatial orientation of multiple functionalities.